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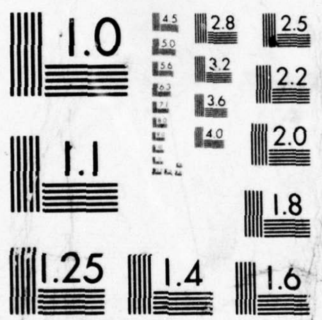

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NATIONAL BUREAU OF STANDARDS-1963-A

US ARMY

TEST & EVALUATION COMMAND

FINAL

REPORT OF

PRODUCT IMPROVEMENT TEST OF U-8F

(ECP-BEA-L23-138)

USATECOM PROJECT NO. 4-4-1004-01

22 DEC 1964

US ARMY

AVIATION TEST BOARD

FORT RUCKER, ALABAMA

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

(9) FINAL rept. Sep-Oct 64.

REPORT OF

(6) PRODUCT IMPROVEMENT TEST OF U-8F

(ECP-BEA-L23-138).

USATECOM PROJECT NO. 4-4-1004-01

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A. J. RANKIN
Colonel, Armor
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ABSTRACT

The Product Improvement Test of the U-8F Airplane (ECP-BEA-L23-138) was conducted by the US Army Aviation Test Board (USAAVNTBD) during September and October 1964. Deicing tests were conducted under artificially-induced ice conditions. Instrumented tests were conducted at the Beech Aircraft Company by Beech personnel. It was found that the ECP-BEA-L23-138 Retrofit Kit was capable of anti-icing and deicing the windshield and propellers of the U-8F airplane; the test system was functionally suitable, the generating system was capable of providing 300 amperes per generator; components of the test system were compatible with each other and with the U-8F; a special tool was required to remove the rearmost generator mounting nuts; noise suppression devices did not reduce noise level in radio compass to an acceptable level; and maximum temperature in the avionic compartment or radome was 149.8°F. at 95°F. ambient temperature. It was recommended that the shortcomings be corrected; propeller deicing time be modified to provide 80-second cycling; and the special tool required to remove rearmost generator mounting bolts be procured with the retrofit kits.

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

FINAL REPORT OF

PRODUCT IMPROVEMENT TEST OF THE U-8F

(ECP-BEA-L23-138)

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UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

FINAL REPORT OF TEST

USATECOM PROJECT NO. 4-4-1004-01

PRODUCT IMPROVEMENT TEST OF THE U-8F
(ECP-BEA-L23-138)

SECTION 1 - GENERAL

1.1. REFERENCES.

A list of references is contained in *appendix I.*

1.2. AUTHORITY.

1.2.1. Directive.

Letter, AMSTE-BG, US Army Test and Evaluation Command, 14 April 1964, subject: "Test Directive for ECP-BEA-L23-138 Prototype," with two inclosures.

1.2.2. Purpose.

To determine changes required in the proposed ECP-BEA-L23-138 retrofit kits.

1.3. OBJECTIVES.

To determine:

a. Compatibility and capability of the proposed retrofit components.

b. Functional suitability of the proposed retrofit kit.

c. Maintenance requirements of the proposed retrofit kit.

1.4. RESPONSIBILITY.

The US Army Aviation Test Board (USAAVNTBD) was responsible for conducting the test and submitting the report of test.

1.5. DESCRIPTION OF MATERIEL.

The ECP-BEA-L23-138 proposed retrofit kit consists of two 300-ampere d.c. generators, a 750-volt-ampere inverter, two electrothermal windshield sections, six propeller boots, and two modified propeller spinner bulkheads.

1.5.1. The generating system consists of the two 300-ampere, brushless generators (figure 1) with integral silicon-controlled rectifier voltage regulators, two control panels, and associated wiring harnesses. The control panels are designed to provide system current-regulation, reverse-current, and over-voltage protection. The generating system weighs 137.6 pounds and has a rating of 100 amperes at 1000 engine r.p.m. (2600 generator r.p.m.) and 300 amperes at 1500 engine r.p.m. (3900 generator r.p.m.) and above.

1.5.2. Generator.

1.5.2.1. The ECP-138 power source is a brushless hetropolar inductor alternator with a silicon-controlled rectifier regulator.

1.5.2.2. The alternator consists of a stator with field and output windings and a rotor. The four field windings are contained in large slots in the stator ninety degrees apart. The output windings are contained in 36 small slots around the periphery of the stator and adjacent to the field windings in the 360-degree position. The rotor consists of magnetic iron punchings secured to a vibration dampening shaft. It is similar to a standard a.c. generator rotor without the windings and commutator.

1.5.2.3. The voltage regulator controls the field power of the generator with the silicon-controlled rectifiers. The percentage of time the controlled rectifier is turned "on" determines the average field voltage applied to the generator and subsequently the generator output.

1.5.2.4. Battery current is required initially for the field windings. After the generator begins to produce current, a portion of that current is directed to the field winding. D.c. current, acting through the field windings in the large stator slots, increases the flux flow around the periphery of the stator and through the rotor. The flux influences rotor poles to switch polarity each ninety degrees creating cyclic variation of the flux to produce a.c. output.

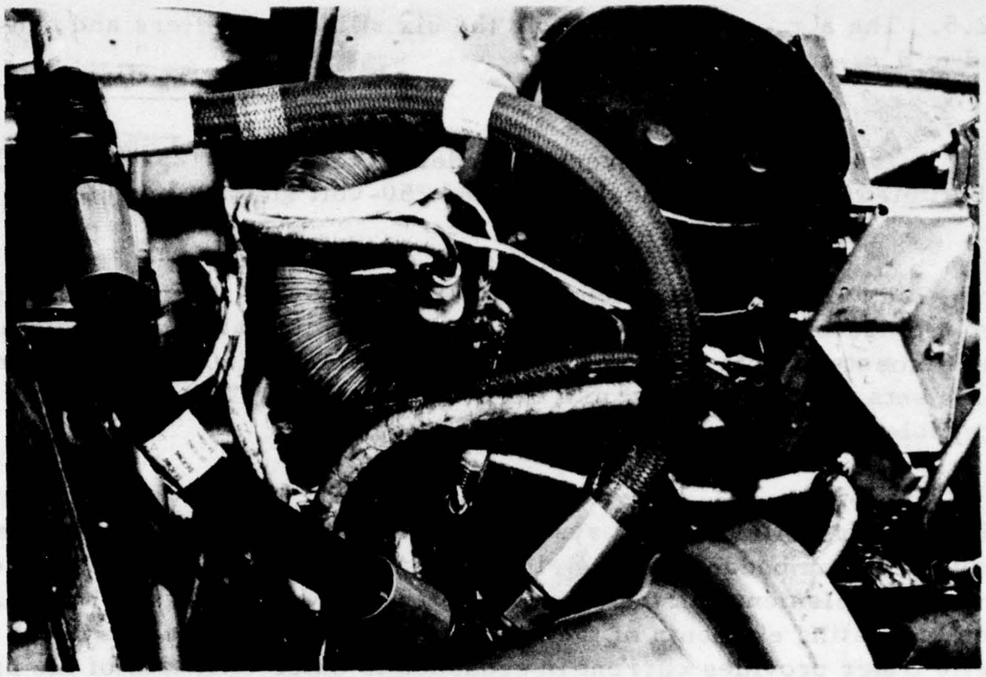

Figure 1. Brushless generator installed on U-8F Airplane.

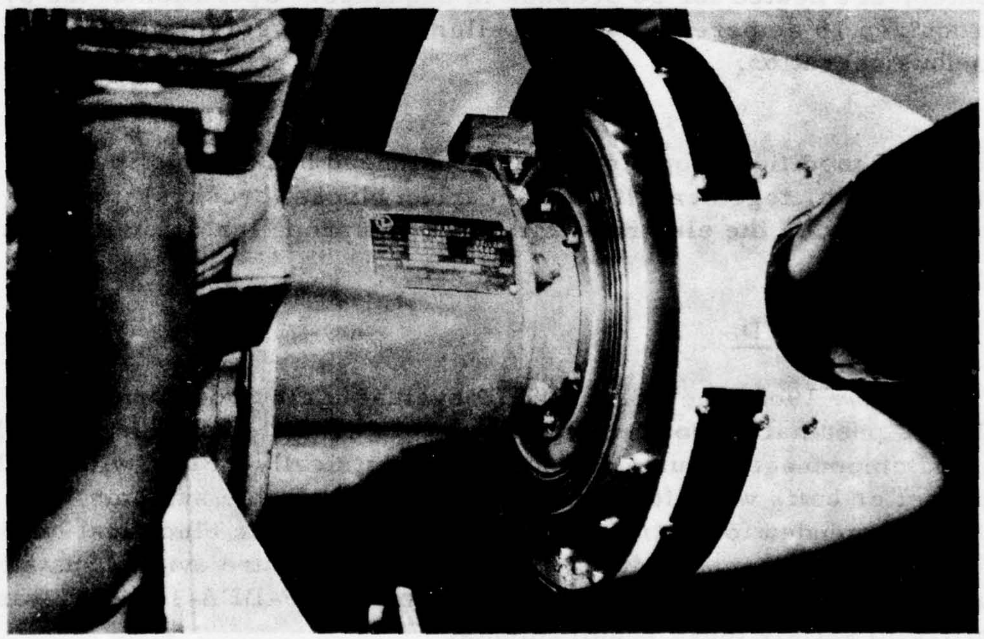

Figure 2. Modified propeller spinner bulkhead showing slip rings.

1.5.2.5. The a.c. output is fed into the six silicon rectifiers and converted to d.c. current.

1.5.3. A 750-volt ampere inverter (Federal Stock No. 6125-660-8100) is substituted for the previously installed 250-volt standby inverter.

1.5.4. The windshields are tempered plate glass with thermostatically-controlled heating elements. A three-position switch allows activation of the elements of both pilot and copilot's windshields (50 amperes), or the elements of pilot's windshield only (25 amperes). The windshields are capable of continuous operation in either mode.

1.5.5. The propeller deicing system uses abrasion resistant neoprene boots with two embedded heating elements on each propeller blade. The inner heating elements on the propeller blades are connected in series. The outer heating elements of the blades are also connected in series. A cyclic timer provides current in sequence to outer elements of the propeller, inner elements of the same propeller; outer elements of second propeller, inner elements of second propeller. The cycle is then repeated. During a two-minute cycle, each of the four boot sections, inner and outer, are heated for 30 seconds in sequence. Operation of the system requires 15 amperes. The propeller deicing system is capable of continuous operation.

1.5.6. The modified propeller spinner bulkhead has three slip rings (figure 2) which, together with three carbon blocks (brushes) mounted on the engine, provide the electrical circuit to the propeller deicing boots.

1.6. BACKGROUND.

1.6.1. In May 1962, the USAAVNTBD evaluated electro-thermal, alcohol, and pneumatic boot deicing and anti-icing systems (reference 6). Wing and empennage pneumatic boots and electrically-heated windshields and propeller cuffs were found to be the more desirable systems, and were recommended for retrofit on U-8F aircraft. The electrical current required for the thermal deicing systems and for future avionic installation necessitated a larger generating system. ECP-BEA-L23-138 was submitted to satisfy these requirements.

1.6.2. During the conduct of the product improvement testing, the U-8 Project Manager's Office requested that the USAAVNTBD measure temperatures within the avionic compartment and radome of the U-8F. These tests were to be conducted with the aircraft parked in an area having a high ambient temperature.

1.7. FINDINGS.

1.7.1. The ECP-BEA-L23-138 Retrofit Kit was capable of anti-icing and deicing the windshield and propellers of the U-8F airplane.

1.7.2. The test system was functionally suitable.

1.7.2.1. A one-minute timing cycle (15 seconds per propeller section) and a two-minute timing cycle (30 seconds per propeller section) removed the propeller ice under test conditions.

1.7.2.2. A 52-second timing cycle (13 seconds per propeller section) did not remove the propeller ice under test conditions.

1.7.2.3. Activation of electrically-heated windshields after entry into icing conditions cleared ice from the heated portion of the windshield.

1.7.3. The generating system was capable of providing 300 amperes per generator.

1.7.4. Components of the test system were compatible with each other and with the U-8F airplane.

1.7.5. A special tool was required to remove the rearmost generator mounting nuts.

1.7.6. Noise suppression devices did not reduce noise level in radio compass to an acceptable level.

1.7.7. Maximum temperature in the avionic compartment or radome was 149.8°F. at 95°F. ambient temperature.

1.8. CONCLUSIONS.

1.8.1. The ECP-BEA-L23-138 Retrofit Kit is suitable for Army use.

1.8.2. Correction of the shortcomings listed in appendix II would enhance the functional suitability of the ECP-BEA-L23-138 Retrofit Kit.

1.8.3. An 80-second propeller-boot timing cycle (20 seconds per propeller section) should be used.

1.9. RECOMMENDATIONS.

It is recommended that:

1.9.1. The shortcomings listed in appendix II be corrected.

1.9.2. Propeller deicing time be modified to provide 80-second cycling.

1.9.3. The special tool required to remove rearmost generator mounting bolts be procured with retrofit kits. Tool specifications are contained in figure 6, section 2.

SECTION 2 - DETAILS AND RESULTS OF SUB-TESTS

2.0. INTRODUCTION.

2.0.1. The test system was installed in a US Army U-8F airplane, serial number 62-3864, by the airframe manufacturer and was released to the US Army Aviation Test Board (USAAVNTBD) on 26 August 1964. The system was flight tested for 107 hours during September and October 1964. Deicing tests were conducted under artificially-induced icing conditions. Natural icing conditions encountered were not sufficient to provide valid test data.

2.0.2. Instrumented tests were conducted at the Beech Aircraft Company by Beech personnel. USAAVNTBD personnel monitored these tests and provided data from USAAVNTBD flight tests concerning system failure and generator paralleling.

2.1. CAPABILITY AND COMPATIBILITY.

2.1.1. Objective.

2.1.1.1. To determine the capability of the ECP-BEA-L23-138 Retrofit Kit for anti-icing and deicing on the U-8F Airplane.

2.1.1.2. To determine the compatibility of the ECP-BEA-L23-138 Retrofit Kit components with each other and with the U-8F Airplane.

2.1.2. Method.

Voltmeters and ammeters were installed on each generator and on the aircraft main d.c. bus to monitor output. The right generator was equipped with 15 thermocouples to measure heating of various components during operation. A type T545A oscilloscope was used to monitor and record transients during switching and normal operation. Selected loads were applied to the generator system using GLB-3A load banks. Throughout the test, aircraft communication, navigation, and other electrical systems were monitored for any signs of abnormal operation.

2.1.3. Results.

Complete test results (from which paragraphs 2.1.3.1. through 2.1.3.6, and 2.1.3.8. through 2.1.3.12. were obtained) are contained in appendix III.

2.1.3.1. Neither system was deliberately faulted to obtain reaction of the second system; however, one system did fail during flight under IFR conditions and the remaining system assumed the entire load.

2.1.3.2. The generators operating independently, or in combination, maintained design voltage at the main aircraft bus.

2.1.3.3. System transients did not cause equipment to become inoperable or induce overheating.

2.1.3.4. Each generator was capable of supplying 4-10 amperes at 750 engine r.p.m. (1950 generator r.p.m.), and 100 amperes at 1000 engine r.p.m. (2600 generator r.p.m.).

2.1.3.5. A single generator provided up to 125 amperes at manufacturer's recommended idle speed, 1000 engine r.p.m. (2600 generator r.p.m.). Load sharing was within manufacturer's specifications during instrumented tests.

2.1.3.6. Generators were tested to a maximum of 3200 engine r.p.m. (8320 generator r.p.m.). Maximum single generator output at this r.p.m. was 300 amperes. To prevent overloading one generator, the maximum total output that was obtained was 592 amperes. Load sharing was within manufacturer's specifications during instrumented tests.

2.1.3.7. Loading sharing was a problem for the first 44 hours of the service test; three attempts were made to provide closer paralleling. These attempts were unsuccessful. After failure of No. 1 generator, the manufacturer reworked the generators and regulators, and paralleling was acceptable for the last 63 hours of test.

2.1.3.8. Cooling air temperature, on exit from the generator, was not excessive.

2.1.3.9. Maximum allowable temperature for the right-hand generator bearing was exceeded during ground tests.

2.1.3.10. Generator cooling was normal after engine shutdown, and no heat soakback was encountered.

2.1.3.11. Current output and loading sharing were not affected by altitude. No detrimental transient effects were noted.

2.1.3.12. Engine compartment ambient temperatures during instrumented tests varied from -1° to $+100^{\circ}F$.

2.1.4. Analysis.

2.1.4.1. Modifications were made to the voltage regulators to preclude reoccurrence of failures experienced during the first 44 hours of service test. After modifications, repair, and recalibration of generators and regulators, no maintenance was required during the remaining 63 hours of testing.

2.1.4.2. Excessive bearing temperatures did not degrade the system, since they occurred only while current in excess of 490 amperes was being produced at 1200 r.p.m.

2.2. FUNCTIONAL SUITABILITY.

2.2.1. Objective.

To determine the functional suitability of the Proposed ECP Retrofit Kit.

2.2.2. Method.

2.2.2.1. A CV-2 airplane was equipped with a water spraying device consisting of eight 55-gallon drums, a gasoline driven pump, a 30-inch spray head on an extended boom, and mounting hardware.

2.2.2.2. Water, which had been colored yellow for photographic purposes, was drawn from the drum into the pump and expelled from the spray head under pressure. Icing tests were conducted at -1° to $-3^{\circ}C$.

2.2.2.3. The test airplane was flown into the water spray with propeller deicing equipment turned off to insure that ice would accumulate on the propeller blades. After formation of ice on propeller blades, the propeller deicing equipment was activated. The timing cycle was then manually varied to determine the shortest cycling period which would clear the ice from the propeller. Presence of propeller ice and degree of cycle efficiency was determined by stopping the right engine, on which tests were conducted, and visually inspecting propeller blades from the copilot's window. All deicing systems were operated individually and in combinations to determine any unfavorable electromagnetic interference characteristics. Navigation instruments were monitored during visual flight conditions. After classification of interference, flights were made under instrument conditions with the equipment operating in all combinations.

2.2.3. Results.

2.2.3.1. Propeller Boot Deicing Cycling Frequency.

Airframe icing condition intensity was a function of distance of test aircraft from spray head and subsequent water particle dispersion. Approximately one inch of ice was accumulated on the airframe during a 12-minute spray run. The maximum amount of ice observed on the propeller blades was 1/4 inch.

2.2.3.1.1. The standard automatic cycling period of two minutes cleared the ice from the propeller boots under test conditions.

2.2.3.1.2. A one-minute cycling period cleared the ice from propeller boots under test conditions.

2.2.3.1.3. A 52-second cycling period did not clear the ice from the propeller boots under test conditions.

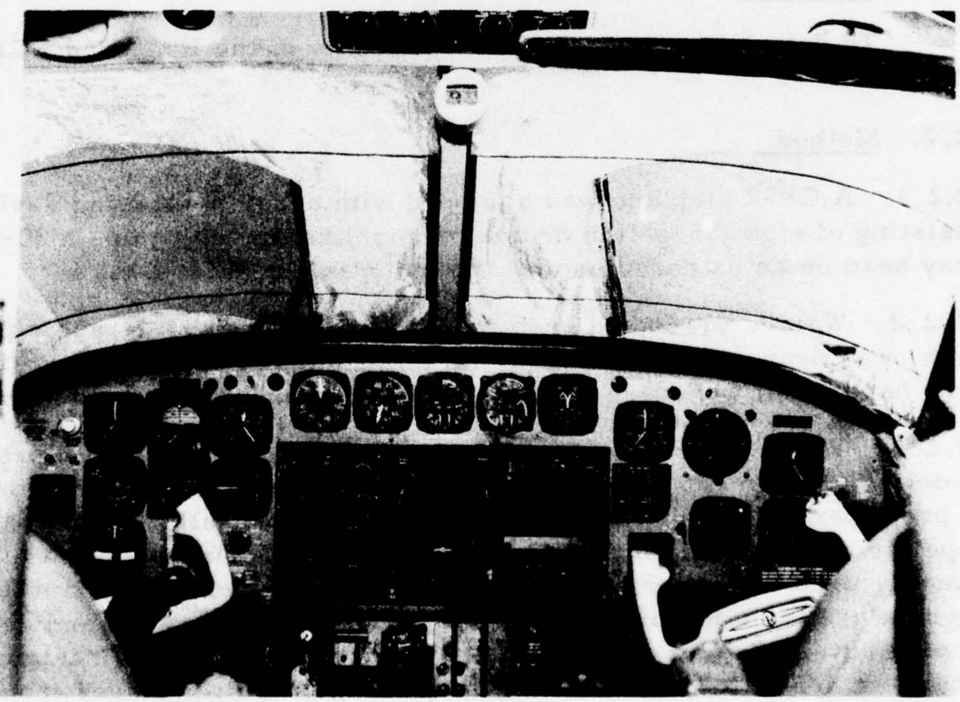

Figure 3. Black lines denote heated area of windshield and the cleared area denotes wiper coverage.

2.2.3.2. Electrically-Heated Windshield.

Activation of electrically-heated windshields after entry into icing conditions cleared ice from the heated portion of windshield. The following shortcomings were noted:

2.2.3.2.1. Windshield heating element had a reflective outer surface which produced a glare when flying into the sun.

2.2.3.2.2. Heated portion of windshield did not correspond to the area cleared by the windshield wiper (figure 3).

2.2.3.2.3. The windshield wiper blades froze to the unheated portion of the windshield. Ice formation on the unheated portion of the windshield raised the wiper blades and prevented contact between the blades and windshield. Actuation of the windshield wipers while the blades were frozen to the windshield displaced the blades 90 degrees and prevented them from wiping the windshield.

2.2.3.2.4. Initial activation of the electric windshield sometimes caused a barely discernible blanking of the AN/APN-158 weather radar scope.

2.2.3.3. Electronic Interference.

Components of the voltage regulator in the generator systems introduced static noise in the low band of the AN/ARN-59 radio compass on loop and ADF positions. The generator manufacturer attempted to reduce the noise, first by the installation of two small filters in the regulator circuit of each generator, and later by winding a grounded number 16 wire around the cables from the generator to the main aircraft bus. These two modifications did not discernibly attenuate the noise in the low band of the radio compass. The two capacitors were then removed from the regulator circuit and a "noise suppressor" was installed in each generator circuit. These devices weighed five pounds each and decreased the static noise slightly. Prior to installation of the manufacturer's three modifications to the generating systems, the maximum range at which usable information could be obtained from the loop position of the radio compass was approximately eight miles. With the ground wire and noise suppressor installed, usable information could be obtained from the loop position up to twelve miles. Operation of the Automatic Direction Finding function of the radio compass was not discernibly affected by the noise of the loop and ADF positions.

2.2.3.4. Effect on Navigation Equipment.

Generators created noise on low band of the radio compass. Initial activation of the electrically-heated windshield occasionally caused a faint blanking of the AN/APN-158 weather radar scope.

2.2.4. Analysis.

2.2.4.1. To insure removal of ice under more extreme temperature conditions than were available for test, an 80-second deicing cycle should be used.

2.2.4.2. The increased use and reliability of modern navigational aids have reduced the requirement for manual loop operation. Therefore, the installation of the partially successful noise suppressors is not recommended because of the weight penalty.

2.3. MAINTENANCE REQUIREMENTS.

2.3.1. Objective.

To determine maintenance requirements of the proposed retrofit kit.

2.3.2. Method.

All scheduled and unscheduled maintenance on the retrofit kit was recorded and the need for special tools noted. All component maintenance was performed by the manufacturer. Unscheduled maintenance performed on the retrofit kit was confined to the voltage regulators and propeller boots. Modifications were made to the system in an attempt to attenuate the noise on the low band of the radio compass. Results of these modifications are contained in paragraph 2.2.3.3.

2.3.3. Results.

2.3.3.1. Voltage Regulators.

2.3.3.1.1. Manufacturer's specifications indicated that generators should parallel within ten percent of the total rated current (60 amperes). Generators were paralleling within twenty amperes, with an induced load of eighty amperes, during ferry flight from Beech Aircraft Company to Fort Rucker, Alabama. Upon arrival at Fort Rucker, a periodic inspection was made on the aircraft. During this inspection,

personnel unfamiliar with the generators attempted to parallel the generators more closely. This resulted in the number one generator assuming the total electrical load. When the number one generator was removed from the line, the number two generator carried the total load effectively.

2.3.3.1.2. A manufacturer's technical representative, dispatched to Fort Rucker to supervise the installation of noise filters on the system, was able to adjust the regulators so that the generators again shared the load within the manufacturer's limits. Enroute to artificial icing tests, the number one generator assumed the total load. All electrical equipment in the aircraft was activated in an attempt to bring the number two generator back into service. This effort was unsuccessful and the number two generator came on only when the number one generator was de-energized. During the next sixteen hours and forty minutes, the electrical power source was alternated by manipulating the generator switches; the generators did not produce power simultaneously.

2.3.3.1.3. After completion of the artificial icing tests, and upon discovery of the slipped propeller spinner and severed deicing boots (figure 4) on the number one propeller, the test aircraft was flown to Beech Aircraft Company for repair of the boots. After installation of new deicer boots, Beech Aircraft Company electricians, following telephonic instructions from the generator manufacturers, attempted to parallel the generators. During this attempt the voltage adjusting mechanism on the number two generator voltage regulator failed. The aircraft was then flown to an airport near the generator manufacturer's plant in Waynesborough, Virginia. The voltage regulator of the number two generator was replaced, and both regulators were adjusted to parallel the generators within the manufacturer's specifications.

2.3.3.1.4. During a two-hour flight to Bridgeport, Connecticut, the number two generator output decreased to approximately five amperes. At this time the number one generator was supplying approximately 65 amperes. During the next eight hours and forty minutes of flight, the paralleling ranged from 60/10 ampere sharing (under actual IFR conditions) to 110/80 ampere sharing (which occurred with all aircraft electrical system activated and the aircraft landing gear being cycled up). Nine hours and forty minutes after the manufacturer had adjusted the generators and during flight under actual IFR conditions, the number one generator went off the line and could not be reset. Prior to the failure, the number one generator had been carrying 45 amperes and the number two seven amperes. When the number one generator failed, the number two carried the load effectively.

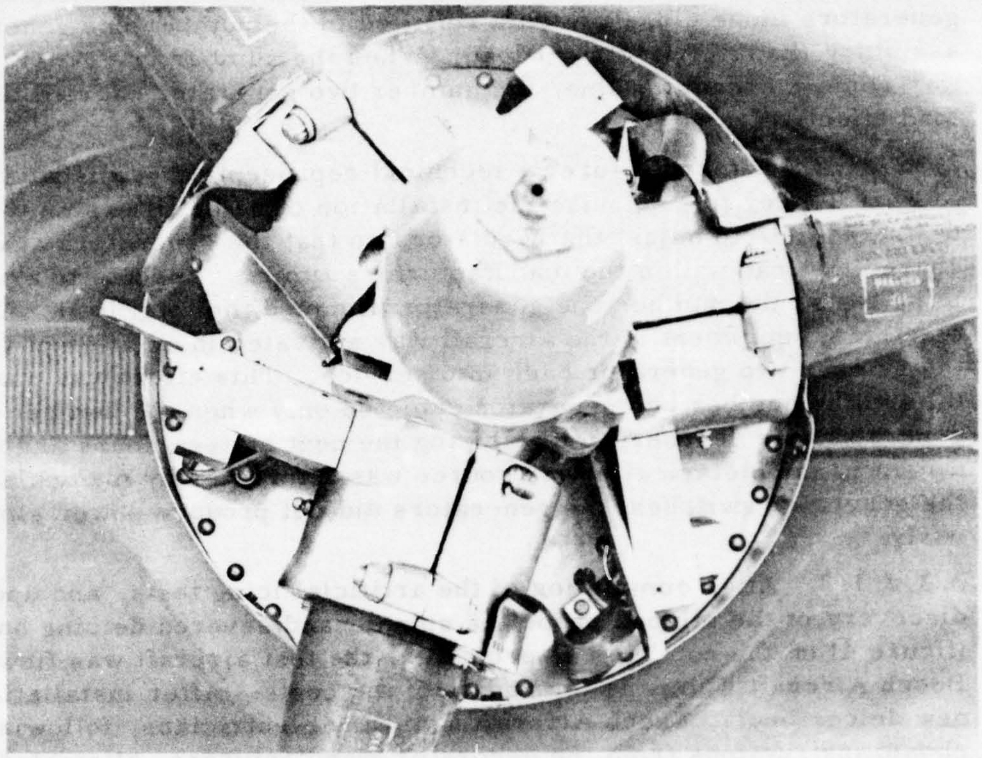

Figure 4. Damaged deicer boots

2.2.3.2. Upon the arrival of the test aircraft at Fort Rucker, the manufacturer's technical representative replaced the number one generator voltage regulator. The replaced regulator had a broken transformer mount and a broken wire in the regulator circuit (figure 5). After replacement of the voltage regulator, the number one generator still would not produce current. The new voltage regulator was later found to be defective. Both generators (and regulators) were then removed from the aircraft and returned to the manufacturer for test, repair, and calibration.

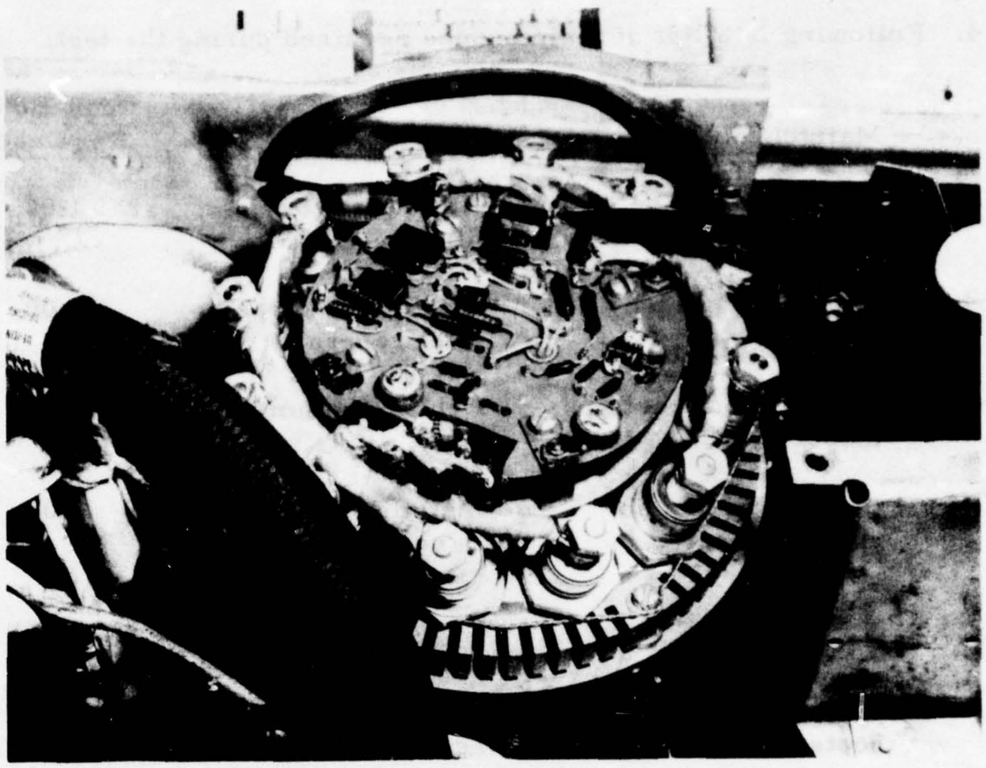

Figure 5. Voltage regulator showing transformer mount failure.

2.2.3.3. After reinstallation of the generators, paralleling was within limits during the remaining 63 hours of the test. This was established by frequent readings of ammeters during normal and maximum possible loading of the generating system.

2.2.3.4. Following is a list of maintenance required during the test:

Date	Maintenance Item	Corrective Action	Man-Hours Required
1 Sep 64	None	Attempted to parallel generator.	1:00
2 Sep 64	Generator not paralleling.	Attempted to parallel generator.	2:00
2 Sep 64	No. 2 volt-ammeter inoperative.	Replaced ammeter.	4:00
2 Sep 64	Low band of radio compass noisy.	Installed capacitors in voltage regulator circuit.	8:00
6 Sep 64	Propeller spinner slipped and severed propeller deicer boots.	Repositioned spinner, retorqued propeller, and replaced boots.	30:00
10 Sep 64	No. 2 generator voltage regulator inoperative.	Replaced and adjusted voltage regulator.	12:00
13 Sep 64	No. 1 generator inoperative.	Both generator and regulators removed, repaired, and reinstalled.	Unknown
22 Oct 64	Low band of radio compass noisy.	Installed ground wire.	Unknown
23 Oct 64	Low band of radio compass noisy.	Installed noise suppressors.	Unknown

Removal and installation of the generators required modification of an existing 5/8-inch wrench. The wrench specifications are contained in figure 6.

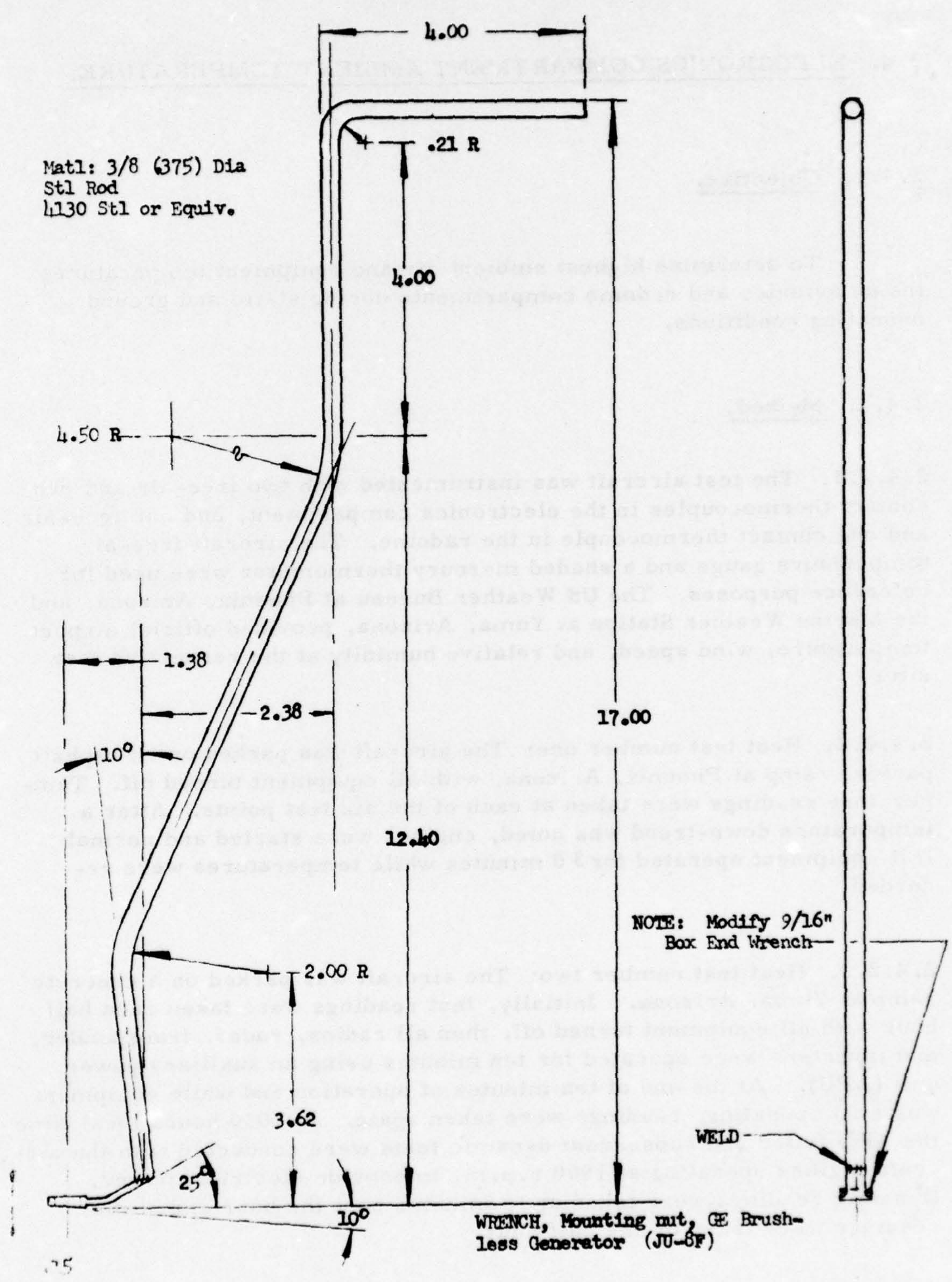

Figure 6. Wrench Specifications

2.4. ELECTRONICS COMPARTMENT AMBIENT TEMPERATURE.

2.4.1. Objective.

To determine highest ambient air and equipment temperatures inside avionics and radome compartments during static and ground operating conditions.

2.4.2. Method.

2.4.2.1. The test aircraft was instrumented with two free-air and two contact thermocouples in the electronics compartment, and one free-air and one contact thermocouple in the radome. The aircraft free-air temperature gauge and a shaded mercury thermometer were used for reference purposes. The US Weather Bureau at Phoenix, Arizona, and the Marine Weather Station at Yuma, Arizona, provided official airport temperature, wind speed, and relative humidity at the respective test sites.

2.4.2.2. Heat test number one: The aircraft was parked on an asphalt parking ramp at Phoenix, Arizona, with all equipment turned off. Temperature readings were taken at each of the six test points. After a temperature down-trend was noted, engines were started and normal IFR equipment operated for 30 minutes while temperatures were recorded.

2.4.2.3. Heat test number two: The aircraft was parked on a concrete ramp at Yuma, Arizona. Initially, test readings were taken each half hour with all equipment turned off, then all radios, radar, transponder, and inverters were operated for ten minutes using an auxiliary power unit (APU). At the end of ten minutes of operation and while equipment was still operating, readings were taken again. At 1030 hours local time the APU failed and subsequent dynamic tests were conducted with the aircraft engines operating at 1500 r.p.m. to provide electrical power. Dynamic readings were taken at 15 minutes past the hour and static readings were taken on the half hour.

2.4.2.4. Thermocouples were installed in the following locations:

Probe Number	Type	Location
1	Free Air	Three inches from roof directly over center of radar synchronizer.
2	Contact	Top of radar synchronizer 2 inches back from face.
3	Contact	Top center of radar RT unit.
4	Contact	Surface-top of antenna mounting bracket.
5	Free Air	Ten inches from roof directly over rear edge of AN/ARC-55 RT unit.
6	Free Air	Directly over wave guide swivel, 6 inches forward of bulkhead.

2.4.3. Results.

Test results are contained in figures 7 and 8.

2.4.4. Analysis.

During test number 2, temperatures were generally lower with equipment operating and engines operating at 1500 r.p.m. than those recorded during static conditions at comparable temperatures.

TEST 1

Time (Local)	US Weather Bureau Data Temp-erature	Wind	Relative Humidity	Acft OAT	Ramp Temp	#1 Probe	#2 Probe	#3 Probe	#4 Probe	#5 Probe	#6 Probe
0800	72	06	39	73	73	70	70	68	71	72	73
0830				76	76.5	77	73.9	69.9	75	78	83.9
0900	75	08	32	79.5	79.5	86.5	77.5	72.5	79.9	84	91.5
0930				82	82	92	81.2	76	87	89.5	101.5
1000	83	05	26	88	86	105	89.9	81.9	95	98	113
1030				93	89.5	110	91.9	84.5	101	104	117
1100	89	05	19	95	91	119.5	102	89	110.5	111.5	129.5
1130				100	92.5	127	111	94.5	118	117	135.5
1200	94	06	18	103	95	132	114	97.9	122	121	140.5
1230				105	100	134	116.7	100	124.8	122.5	144.9
1300	95	03	17	106.5	97.5	134.7	119	106.5	128.6	123.6	149
1330				107.5	98.5	135.6	121.7	111.2	132	124.2	149.8
1400	96	04	15	110	99	132	122	113.5	130	122	142
1430				112	100	132.5	124	116.5	133	123	149.2
1500	97	06	15	107	105*	132.7	125.7	118.5	131	123	145.5
1530				107	101	130	126.5	120.5	131	122.5	144.5
1600*	97		15			123	123.5	118.5	124	117	128
1608						123	118.5	122.5	123	117	127.5
1613						124.5	123.5	124	122	118	123
1618						126.5	129.5	128	124.5	120.2	121
1623						127	132	134	126	124.5	120.5
1628						129.5	135.5	138.5	126	125.5	120
1630	96	05	15	100	100	129.5	135.5	140.5	128.3	127.9	123.7

*Thermometer was exposed to direct rays of sun.

Note: After a temperature down trend was noted, engines were started and all radios, radar, and transponders were operated for 30 minutes while temperatures were recorded.

Figure 7.

TEST 2

Time (Local)	USMC Air Station Data Temp-erature	Wind	Relative Humidity	Acft OAT	Ramp Temp	#1 Probe	#2 Probe	#3 Probe	#4 Probe	#5 Probe	#6 Probe
0830	72	04	66	82	82	90	85	81	82	83	88
						(92)	(87.5)	(84.2)	(84)	(86.3)	(88.5)
0900	78	04	60	84	83	98	91.5	88	88	90.5	91.5
						(106)	(95)	(93)	(87.5)	96	93
0930				86	85	110	104	102.5	92	105	101
						(112)	(115.5)	(103)	(92)	(106)	(102)
(1) 1000	84	05	44	89	87	112	108	106	92.5	106	102
						(114.5)	(117.8)	(117.2)	94	(109.5)	(105.8)
1100	87	C	40	99	91	132.2	114.3	109	119.5	122	141
						(128.5)	(115.5)	(116.2)	(121.8)	(122.5)	128
1130				104	92	137	121.5	120.2	124.8	126	143.2
1200	91	03	33	110	92.5	145	125	121.5	130	128.5	149.5
						(136)	(125.5)	(126.5)	(126.5)	(128)	(132)
1230				104	94.5	143	129.5	129	128	131	145.5
1300	95	04	24	106	99	141	131	128.5	132	131.9	146.5
						(139.5)	(130.5)	(131.5)	(129.5)	(131)	(135.5)
1330				115	98	147	138.5	138	133	135.5	149
1400	97	C	25	108	99	147	139.5	137	133.5	137	149
						(140.5)	(139.5)	(142)	(131.1)	(135.5)	(131.5)
(2) 1430				109	105	144	142.9	143.5	133	138.5	143
1500	99	04	18	102	101	142	141.5	141	128	136	137
						(140.5)	(141)	(142)	(125.5)	(135.5)	(129.5)
1530				101	100.5	136.5	140.2	140.5	124	135.2	133
1600	99	08	14	100	100.5	138.5	139.5	139	119	129.2	128
						(134)	(136.5)	(135)	(119.5)	(130)	(125.5)

Rdgs in parens. were taken after 10 minutes of operation of OMNI/ADF, inverter, radar, UHF, VHF, and transponder.

1. Aircraft heading changed from 360° to 180° after this reading.

2. Jets had just run up--w/jet blast blowing on U-8F.

Figure 8.

SECTION 3

APPENDICES

APPENDIX I

LIST OF REFERENCES

1. Letter, AMSTE-BG, US Army Test and Evaluation Command, 14 April 1964, subject: "Test Directive for ECP-BEA-L23-138 Prototype," with two inclosures.

2. Plan of Test, USATECOM Project No. 4-4-1004-01, "Product Improvement Testing of the U-8F (ECP-BEA-L23-138), US Army Aviation Test Board, Undated.

3. Beech Aircraft Corporation Engineering Test Request No. 9867, 16 April 1964.

4. Letter Report, ATBG-DT AVN 1861.1, US Army Aviation Board, 21 April 1961, subject: "Evaluation of L-23F Deicing and Anti-icing Systems."

5. Letter, SMOSM-EUU-8, US Army Aviation Materiel Command, 21 April 1964, subject: "USATEC Project - Task #4-4-1004-01, U-8F ECP-BEA-L23-138," with two inclosures.

6. Letter Report, ATBG-AC AVN 1861.1/62, US Army Aviation Board, 2 May 1962, subject: "Report of Test, Project No. AVN 1861.1/62, Evaluation of L-23F De-icing and Anti-Icing Systems."

7. Beech Aircraft Corporation Memorandum Report 20177, "Generator Temperature and Functional Test on Units Manufactured by General Electric Co.," 14 October 1964.

APPENDIX II

SHORTCOMINGS

Shortcoming	Suggested Corrective Action	Remarks
1. Generating system produced noise in the radio compass which reduced effectiveness of the loop antenna.	Isolate and eliminate source of noise.	None.
2. Windshield heating element had a reflective outer surface which produced a glare when flying toward the sun.	Coat windshield heating element with non-reflective material.	The coating should not appreciably degrade the present degree of visibility.
3. Heated portion of windshield did not correspond to area cleared by windshield wiper.	Expand heated portion of windshield to cover area cleared by windshield wiper.	None.
4. Initial activation of electric windshield sometimes caused a barely discernible blanking of the AN/APN-158 weather radar scope.	Isolate and eliminate source of interference.	None.
5. Propeller spinner slipped and severed propeller deicing boots.	The propeller boots be modified to prevent damage in the event of propeller spinner slippage.	None.
6. A maintenance package was not provided.	Provide a maintenance package.	None.

APPENDIX III

STATISTICAL DATA OBTAINED FROM INSTRUMENTED TESTS

ALTERNATOR GROUND OPERATION
FIGURE 9

MISCELLANEOUS				ELECTRICAL									TEMPERATURES °F (RH ALTERNTOR ONLY)																	NOTES
		Pres		RPM		Volts			Amperes				Air			Vltg Reg.		Brg.	Rectifiers				Frame	Windings				Add	
	Event	Alt.	IAS			Main	Alternator		Alternator		Load Bank			Alternator				Drive	Negative		Positive		Altr	DC		AC		For Std	
Date	Time	Feet	KPH	Eng	Altr	Bus	LH	RH	LH	RH	LH	RH	OAT	In	Out	A	B	End	A	B	A	B		A	B	A	B	Hot Day °F.	
													Max Allowable →			212	212	248	293	293	293	293	356	446	446	446	446		
5/21/4	2:40	-	-	1100	2860	28.5	28.6	28.6	101	98	-	200																	Parallel at 300 Amps
				1100	2860	28.5	28.6	28.6	80	80	-	160																	
				1100	2860	28.6	28.7	28.7	60	68	-	128																	
				1100	2860	28.6	28.7	28.7	44	60	-	100																	
				1100	2860	28.7	28.8	28.8	10	40	-	50																	
				1100	2860	28.8	28.9	28.9	4	18	-	16																	
				2000	5200	28.5	29.3	29.2	300	256	248	328																	
				2000	5200	28.5	29.2	29.1	280	240	248	288																	
				2000	5200	28.5	29.1	29.1	240	208	248	208																	
				2000	5200	28.5	29.1	29.1	200	180	248	136																	
				2000	5200	28.5	29.0	29.0	160	148	256	56																	
				2000	5200	28.5	28.8	28.8	120	120	184	56																	
				2000	5200	28.5	28.7	28.7	80	84	104	56																	
				2000	5200	28.5	28.7	28.7	40	60	38	56																	
				2000	5200	28.5	28.6	28.7	20	52	8	56																	
				2000	5200	28.6	28.6	28.6	4	20	8	8																	
				2000	5200	28.6	-	29.1	-	260	-	-																	LH OFF
				2000	5200	28.1	28.9	-	260	-	-	-																	RH OFF
				2000	5200	28.5	-	29.0	-	196	-	-																	LH OFF
				2000	5200	28.0	28.7	-	216	-	-	-																	RH OFF
				1000	2600	28.5	28.6	28.6	40	520	-	92																	
				1000	2600	26.1	26.4	-	88	-	-	84																	RH OFF
				1000	2600	26.9	-	27.1	-	82	-	86	55	60	119	78	83	143	107	114	98	98	184	150	144	193	193	40	LH OFF

All Test Meters Fluctuate On Above Readings

ALTERNATOR FLIGHT OPERATION
FIGURE 10

MISCELLANEOUS						ELECTRICAL							TEMPERATURES °F (RH ALTERNATOR ONLY)																NOTES
		Pres		RPM			Volts		Amperes				Air			Vltg Reg.		Brg.	Rectifiers				Frame	Windings				Add For Std Hot Day °F.	
						Main	Alternator		Alternator		Load Bank			Alternator				Drive	Negative		Positive		Altr	DC		AC			
Date	Event Time	Alt. Feet	IAS KPH	Eng	Altr	Bus	LH	RH	LH	RH	LH	RH	OAT	In	Out	A	B	End	A	B	A	B		A	B	A	B		
													Max. Allowable		→	212	212	248	293	293	293	293	356	446	446	446	446		
5/22/4	3:40	9000	140	2650	6890	27.5	28.2	28.1	316	296	280	288	All Temperatures During This Flight Were Below Limits - No Data Recorded																Parallel at 300 amps
						28.1	29.1	29.0	300	280	-	-																	
						28.4	29.2	29.1	280	260	-	-																	
						28.5	29.2	29.1	260	248	-	-																	
						28.5	29.2	29.1	240	232	-	-																	
						28.6	29.2	29.1	220	212	-	-																	
						28.5	29.1	29.0	200	192	-	-																	
						28.5	29.0	28.9	180	176	-	-																	
						28.6	29.0	29.0	160	152	-	-																	
						28.6	28.9	28.9	140	136	-	-																	
						28.6	28.8	28.8	120	120	-	-																	
						28.6	28.8	28.8	100	108	-	-																	
						28.5	28.7	28.7	80	92	-	-																	
						28.5	28.6	28.6	60	72	-	-																	
						28.5	28.6	28.6	40	60	-	-																	
						28.5	28.6	28.6	20	52	-	-																	
						28.6	28.6	28.7	8	40	-	-																	
						28.5	29.0	28.9	150	150	-	-																	
						28.2	-	-	-	72	-	-																	
						28.0	-	-	76	-	-	-																	
						28.6	-	-	37	37	-	-																	
						27.5	28.2	28.2	320	296	280	284																	

All Test Meters Fluctuate On Above Readings

ALTERNATOR GROUND OPERATION
FIGURE 11

MISCELLANEOUS						ELECTRICAL						
		Pres		RPM		Volts			Amperes			
	Event	Alt.	IAS			Main	Alternator		Alternator		Load Bank	
Date	Time	Feet	KPH	Eng	Altr	Bus	LH	RH	LH	RH	LH	RH
5/26/4						LH Alternator Cuts In At 750 RPM						
						RH Alternator Cuts In At 725 RPM						
5/26/4	10:47	-	-	750	1950							
	11:07	-	-	850	2200	27.8	27.9	27.8	4	4	-	-
	11:09	-	-	900	2375	28.0	28.0	28.0	12	8	-	16
	11:17	-	-	1000	2600	28.0	28.3	28.2	88	96	-	184
	11:23	-	-	1100	2900	28.0	28.5	28.5	204	188	56	328
	11:28	-	-	1200	3100	28.0	28.6	28.5	256	240	160	328
	11:35	-	-	-	-	-	-	-	-	-	-	-
	11:40	-	-	-	-	Temperatures Taken After Engine Shutdown						
5/26/4	14:20	-	-	800	2100	27.0	27.0	27.0	2	4	-	-
	14:22	-	-	800	2100	27.0	27.0	-	6	-	-	-
	14:25	-	-	800	2100	27.0	-	27.0	-	6	-	-
	14:40	-	-	1000	2600	28.0	28.2	28.1	124	104	-	208
	14:45	-	-	1000	2600	-	-	-	115	110	-	-
	14:50	-	-	1200	3100	28.0	28.5	28.5	256	240	112	304
	14:55	-	-	1200	3100	-	-	-	245	240	-	-
	Temperatures After Engine Shut Off											
5/27/4	10:50	-	-	1000	2600	28.5	28.6	28.7	44	56	-	72
	11:13	-	-	1000	2600	28.5	28.6	28.7	44	56	-	66
	13:26	-	-	1000	2600	28.5	28.6	28.6	96	104	-	160
	13:36	-	-	1000	2600	28.5	28.6	28.6	96	104	-	160
	13:41	-	-	1000	2600	28.5	28.6	28.6	96	104	-	160
	14:25	-	-	1600	4160	28.0	28.6	28.7	320	300	245	320
	14:35	-	-	1600	4160	27.4	28.1	28.0	320	300	240	328
						All Test Meters Fluctuate On Above Readings						

Date	Event Time	TEMPERATURES °F (RH ALTERNATOR ONLY)																NOTES
		Air			Vltg Reg.		Brg.	Rectifiers				Frame	Windings				Add	
			Alternator				Drive	Negative		Positive		Altr	DC		AC		For Std	
		OAT	In	Out	A	B	End	A	B	A	B		A	B	A	B	Hot	
		Max. Allowable		→	212	212	248	293	293	293	293	356	446	446	446	446	Day °F.	
5/26/4																		Parallel at 300 Amps
5/26/4	10:47	88	95	219	191	179	213	149	153	123	122	262	291	302	254	252	7	
	11:07																	
	11:09	90	100	246	175	157	235	147	149	121	118	294	283	295	287	293	5	
	11:17	92	102	237	185	179	231	164	168	142	145	288	297	303	291	287	3	
	11:23	93	102	252	175	163	244	187	200	174	178	315	292	315	330	319	2	
	11:28	92	100	267	176	164	258	218	229	193	196	346	304	336	375	359	3	
	11:35	92	120	230	160	158	245	189	189	154	154	330	294	325	327	317	1	
	11:40	94	118	208	152	144	230	175	175	148	148	297	267	287	296	287	1	
5/26/4	14:20																	
	14:22																	
	14:25																	
	14:40	97	107	237	178	165	225	187	190	162	164	286	280	296	291	287	-2	
	14:45																	
	14:50	96	106	296	210	196	284	245	255	211	216	393	364	401	425	414	-1	
	14:55																	
	Temperatures After Engine Shut Off	97	121	243	173	163	259	205	207	173	173	350	311	331	351	345	-2	
		The Following Temperatures Were Taken During Rain - They Are Below Normal.																
5/27/4	10:50																	
	11:13	65	77	149	107	103	157	115	115	103	103	175	169	166	169	167	30	
	13:26	52	60	131	100	93	133	117	117	103	103	164	164	161	163	162	43	
	13:36	53	61	147	103	93	148	121	121	106	106	179	175	171	175	173	42	
	13:41	53	61	158	115	106	159	126	126	109	109	196	202	197	192	192	42	
	14:25	32	32	153	78	83	156	138	151	123	123	218	191	196	240	243	63	
	14:35	57	27	196	86	90	200	150	170	133	133	302	256	262	320	310	38	

ALTERNATOR FLIGHT OPERATION
FIGURE 12

MISCELLANEOUS						ELECTRICAL							TEMPERATURES °F (RH ALTERNATOR ONLY)																NOTES
				RPM		Volts			Amperes				Air			Vltg Reg.		Brg.	Rectifiers				Frame	Windings				Add For Std Hot Day °F.	
		Pres Alt.	IAS			Main	Alternator		Alternator		Load Bank			Alternator				Drive	Negative		Positive		Altr	DC		AC			
Date	Event Time	Feet	KPH	Eng	Altr	Bus	LH	RH	LH	RH	LH	RH	OAT	In	Out	A	B	End	A	B	A	B		A	B	A	B		
													Maximum Allowable	→		212	212	248	293	293	293	293	356	446	446	446	446		
5/28/4	10:20					ALTERNATORS TURNED ON																							
	10:35	2500	140	2600	6760	28.8	29.7	29.7	292	300	216	248	56	63	121	77	82	138	102	110	93	93	190	148	142	186	182	35	Parallel at 300 Amps
	10:50	2500	140	2600	6760	28.8	29.6	29.6	292	300	216	240	56	61	122	76	80	142	101	108	92	92	188	151	140	186	180	35	
	11:05	8000	135	2600	6760	28.8	29.5	29.5	292	300	216	240	44	48	117	65	70	140	93	99	82	82	191	149	138	191	191	27	
	11:20	8000	135	2600	6760	28.8	29.5	29.5	292	300	216	240	44	49	117	65	73	140	95	98	85	85	195	151	142	195	195	27	
	11:35	12000	130	2600	6760	28.7	29.5	29.5	292	300	208	248	39	45	119	62	68	142	94	101	82	82	204	156	149	206	206	18	
	11:45	12000	130	2600	6760	28.7	29.5	29.5	292	300	208	248	39	46	120	64	70	143	96	101	83	83	205	159	150	207	207	18	
	11:46	12000	130	2600	6760	28.8	-	-	268	280	-	-																	
	11:47	12000	130	2600	6760	29.0	-	-	220	240	-	-																	
	11:48	12000	130	2600	6760	29.0	-	-	172	200	-	-																	
	11:49	12000	130	2600	6760	29.0	-	-	68	160	-	-																	*See note below
	11:50	12000	130	2600	6760	29.0	29.1	29.5	20	140	-	-																	*See note below
5/29/4	9:25	20000	125	2800	7280	28.6	29.3	29.4	292	300	208	248	3	16	104	37	45	132	81	81	68	65	210	152	126	207	202	25	
	9:30	20000	125	2800	7280	28.6	29.3	29.4	292	300	208	248	5	14	105	37	45	132	80	81	66	62	211	141	125	207	202	23	
	9:40	20000	125	2800	7280	28.6	29.3	29.4	292	300	208	248	5	14	104	35	40	127	77	87	66	61	208	149	126	208	202	23	
	9:45	20000	125	2800	7280	28.6	29.3	29.4	292	300	208	248	5	13	103	35	40	127	77	87	65	61	208	149	125	207	202	23	
	10:30	27000	110	3200	8320	28.5	29.2	29.3	292	300	216	248	-18	-1	126	32	38	159	84	90	56	51	246	174	145	248	183	21	
	10:40	27000	110	3200	8320	28.5	29.1	29.1	292	300	216	248	-23	-11	116	22	29	148	73	-	53	47	242	166	138	240	184	26	
	10:50	27000	110	3200	8320	28.5	29.1	29.2	292	300	216	248	-22	-11	111	20	26	143	73	-	54	47	237	164	134	238	184	25	
	11:00	27000	110	3200	8320	28.5	29.2	29.2	292	300	216	248	-22	-12	110	17	24	141	70	-	53	48	238	164	134	238	172	25	
	11:10	27000	110	3200	8320	28.5	29.2	29.2	292	300	216	248	-22	-12	100	17	22	133	64	-	51	47	224	153	126	224	172	25	
	11:20	27000	110	3200	8320	28.5	29.2	29.3	292	300	216	248	-22	-12	100	17	22	133	66	-	52	47	228	158	129	228	178	25	
	11:22	27000	110	3200	8320	28.5	29.2	29.3	292	300	216	248	-22	-12	100	17	22	133	66	-	52	47	230	160	130	230	180	25	
	11:24	27000	110	3200	8320	28.5	29.2	29.3	292	300	216	248	-22	-12	100	17	22	133	66	-	52	47	230	159	132	230	182	25	
	11:26	27000	110	3200	8320	28.5	29.2	29.3	292	300	216	248	-22	-12	100	17	22	133	66	-	52	47	230	160	130	230	183	25	
	11:28	27000	110	3200	8320	28.9	28.9	29.2	6	126	-	-																	*See note below
	11:30	27000	110	3200	8320	29.0	29.0	29.4	0	120	-	-																	*See note below
	11:32	27000	110	3200	8320	29.0	29.0	29.4	5	140	-	-																	*See note below

ALL TEST METERS FLUCTUATE ON ABOVE READINGS (AMMETER FLUCTUATE ±5 AMPERES)

*The alternators, for this flight operation, were adjusted to parallel at approximately 300 amperes each to produce rated output for maximum temperature tests. The manufacturer recommends that the alternators should be paralleled at 150 amperes each, for normal operation, which should maintain a load balance within 60 amperes differential. *Therefore, it is assumed that the broad differential* in paralleling indicated here would be reduced to the manufacturer's specifications when paralleled at 150 amperes each. This is indicated by the ground operation data in Figure 13.

ALTERNATOR GROUND OPERATION
FIGURE 13

Memorandum Report 20177
October 14, 1964

MISCELLANEOUS						ELECTRICAL							TEMPERATURES °F (RH ALTERNATOR ONLY)																NOTES
		Pres		RPM		Volts			Amperes				Air			Vltg Reg.		Brg.	Rectifiers				Frame	Windings				Add For Std Hot Day °F.	
						Main	Alternator		Alternator		Load Bank			Alternator				Drive	Negative		Positive		Altr	DC		AC			
Date	Event Time	Alt. Feet	IAS KPH	Eng	Altr	Bus	LH	RH	LH	RH	LH	RH	OAT	In	Out	A	B	End	A	B	A	B		A	B	A	B		
													Max. Allowable →			212	212	248	293	293	293	293	356	446	446	446	446		
6/1/4	10:20	-	-	800	2100	BATTERY VOLTS ONLY																							
	10:25	-	-	900	2375	28.5	28.5	28.5	4	16	-	18	68	82	185	173	164	184	116	124	96	96	216	264	274	210	210	27	
	10:35	-	-	1000	2600	28.5	28.7	28.7	82	88	58	106	66	80	181	144	116	181	131	131	114	114	222	213	213	213	202	29	
	10:45	-	-	1100	2900	28.5	28.9	28.9	132	132	-	248	64	72	182	120	111	184	146	146	128	128	223	209	209	222	205	31	
	10:55	-	-	1200	3100	28.5	28.9	28.9	164	160	112	208	63	74	188	118	111	187	153	153	135	135	234	213	213	234	215	32	
	11:05	-	-	1300	3380	28.5	28.9	28.9	180	175	152	192	64	70	194	116	107	193	156	156	137	137	243	216	216	244	222	31	
	11:15	-	-	1400	3640	28.5	28.9	28.9	161	159	120	192	64	76	190	112	105	192	148	148	128	128	237	230	228	232	214	31	
	11:25	-	-	1500	3900	28.5	29.0	29.0	175	168	192	136	64	75	187	110	104	190	146	146	130	130	234	204	204	230	233	31	
	11:35	-	-	1600	4160	28.5	29.0	29.0	208	200	200	200	64	74	191	111	106	192	151	151	133	133	243	211	211	242	224	31	
	11:43	-	-	1600	4160	28.5	29.0	29.0	150	150	-	280																	Parallel at 150 Amps
	11:44	-	-	1600	4160	28.5	28.9	28.9	112	120	-	216																	
	11:45	-	-	1600	4160	28.5	28.8	28.8	90	100	-	175																	
	11:46	-	-	1600	4160	28.7	28.8	28.8	64	80	-	130																	
	11:47	-	-	1600	4160	28.8	28.9	28.9	16	60	-	64																	
	11:48	-	-	1600	4160	28.9	28.9	28.9	8	40	-	38																	
	11:49	-	-	1600	4160	28.9	28.9	28.9	4	20	-	16																	
	11:50	-	-	1300	3380	28.5	29.0	29.0	160	156	192	112	65	78	205	121	110	204	158	160	138	138	250	224	224	248	230	30	
	12:00	-	-	1300	3380	28.5	29.0	29.0	160	156	192	112	65	76	202	120	111	202	155	155	138	138	248	222	222	246	228	30	

ALL TEST METERS FLUCTUATE ON ABOVE READINGS.

APPENDIX IV - DISTRIBUTION LIST

USATECOM PROJECT 4-4-1004-01

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US Army Aviation Test Board, Fort Rucker, Alabama. Final Report of USATECOM Project No. 4-4-1004-01, Product Improvement Test of the U-8F Airplane (ECP-BEA-L23-138), 15 December 1964. DA Project No. None. 44 pp., 13 illus. Unclassified. Six shortcomings were noted during the test. It was recommended that the shortcomings be corrected; propeller deicing time be modified to provide 80-second cycling; and the special tool required to remove rearmost generator mounting bolts be procured with the retrofit kits.

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